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Glaucony ages of Vindhyan sediments in Rajasthan

A P Srivastava and G Rajagopalan
Birbal Sahni Institute of Palaeobotany, 53, University Road,
P. B. No. 106, Lucknow-226 007, India

Abstract : This report deals with the fission track (F-T) dating and geological correlation of glauconitic sandstone beds of Vindhyan sediments in Rajasthan. The glaucony F-T ages of sandstone beds exposed at Bodwali in Chittorgarh district and at Astal village in Karauli area are reported. Except for the sample from Bodwali, which is dated to 1070 Ma, the ages of the other samples range from 600-700 Ma. On the basis of F-T age data, geological correlation of Vindhyan deposits in Rajasthan with those in eastern part at Son Valley and Chitrakut has been attempted. Apatite mineral age for the Bearch granite, the base rock of Vindhyan sediments at Chittorgarh has been obtained as 1470 Ma.

Keywords : F-T dating, apatite, glauconite, Vindhyan supergroup, Bhander formation, base granite.

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1. Introduction

Vindhyan Supergroup is one of the largest and perhaps the oldest undisturbed glauconite bearing deposits in the world. The Vindhyan deposits cover a very large area in Central India : from Sasaram, Bihar in the east to Chittorgarh, Rajasthan in the west ; from Agra in the north to Hoshangabad in the south (Figure 1). Auden (1933) classified Vindhyan deposits into two groups, i.e. Lower Vindhyan group (or Semri series) and Upper Vindhyan group consisting of Kaimur, Rewa and Bhander formations. The type area for Lower Vindhyan deposits are Chopan, Son Valley in Mirzapur district and Chitrakut in Banda district in east and area around Chittorgarh in Rajasthan in the west.

F-T dating of glaucony had been applied for glauconitic sandstone of various profiles exposed at Chitrakut and Chopan area (Srivastava 1987). The extension of this work at various localities in SW and SE Rajasthan is being presented in this paper. Glauconitic standstone samples have been collected from Bodwali in Chittorgarh district and Sapotra-Karauli region in SE Rajasthan. The base rock Bearch granite exposed at Det village, Chittorgarh has also been dated.

2. General geology of the area

Singh (1883), Coulson (1927) and Heron (1917, 1936) laid the foundation for the geology of the Western part of Vindhyan basin. In recent years Prasad (1965-1971)

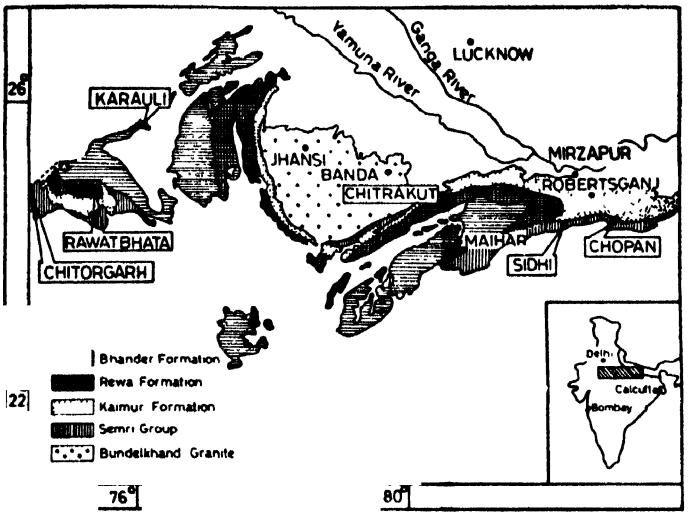

Figure 1.

had done detailed mapping of Vindhyan deposits in Rajasthan, establishing the stratigraphy (Prasad 1984). The revised lithostratigraphy of Vindhyan supergroup in Rajasthan is given in Table 1.

The descriptions of the localities from where glauconitic sandstone samples have been collected are given below :

1. Astal : This village is at about 4 km from Karauli city on Karauli-Gangapur road. A flat-topped hillock range is seen from the road itself. The samples have been collected from a trench on a hillock, close to the road. Probably, the trench was dug for road filling. Here the reddish-brown shale is exposed at road level, which is overlain by 5 m thick glauconitic sandstone bed. At the top, fine and coarse grained standstones are exposed. The hillocks are covered by 1 m thick alluvium.

2. Bodwali : This village is situated near Pangarh, about 70 km N-NE of Chittorgarh city. In this locality, number of flat-topped hillocks are present near a rainfed channel or nala. Ferrugeneous rock fragments are found strewn in the nala and on the flat topped hillocks. The glauconitic sandstone samples are collected from two beds of 10 cm thickness situated at about 2 m from the nala bed and separated vertically from each other by about 30 cm. The bed lying on top has dark green glauconitic grains. Brown and green shale is the dominant constituent of the litho-column.

3. Det : This place is 10 km from Chittorgarh city on Chittorgarh-Ajmer road. Here Bearch granite is exposed over a large area. Grey and white chert in-filling the rock body was also observed at number of places.

Table 1. Lithostratigraphy of Vindhyan supergroup.

Groups		Formations in Western part (after Prasad 1984)	Formations in Eastern part (after Auden 1933)
UPPER	Bhander (Upper)		
	Bhander (Lower)	Sirbu shale Bundi Hill sandstone Somaria shale Lakheri limestone Ganugarh shale	
	Rewa	Govindgarh sandstone Jhiri shale Indargarh sandstone Panna shale	
	Kaimur	Akoda Mahadev sandstone Badanpur conglomerate Chittaur fort sandstone	
LOWER	Khorip	Suket shale Nimbahera limestone Bari shale Jhiran sandstone	Rohtas/Tirohan limestone
	Lasrawan	Binota shale Kalmia sandstone	Kheinjua shale/ sandstone
	Sand	Palri shale Sawa sandstone	Porcellanite/ Pellet limestone
	Satola	Bhagwanpura limestone Khardeola sandstone Khairmalia andesite	Basal conglo-merate
		Unconformity	
		Bearch granite	Bijawars

3. Experimental procedure

The methodology for the separation of the glauconitic grains has been described in detail by Srivastava (1985, 1987). The only alteration made in the settings of isodynamic magnetic separator was that the current kept at a lower value of 0.4 amp, which confirms well evolved nature of these glauconitic grains (Odin and Dodson 1982). The separated grains were mounted, ground and polished.

The etching of the polished grains embedded in Araldite moulds was carried out in the mixture of 1 H_2SO_4 (98%) : 2 HF (48%) : 4 H_2O at room temperature for 35 minute. The fossil track density (ρ_s) was calculated after scanning all grains and counting the tracks. One aliquot of these grains was sent for thermal neutron irradiation at CIRUS reactor, BARC, Bombay and induced track density (ρ_i) was obtained from these grains using the same method of mounting, grinding, polishing and etching. To measure the thermal neutron dose (ϕ), a piece of standard uranium glass (Blue star microscope slide, Saini *et al* 1981) and Fisher standard glass were also sent for irradiation alongwith the samples.

The F-T age is obtained after substituting the values in the formula :

$$T = 14854 \log \left\{1 + 9.32 \times 10^{-18} \times \frac{\rho_s}{\rho_i} \times \phi\right\} \text{ Ma} \qquad (1)$$

and statistical error is obtained by the formula (Srivastava 1985) :

$$\Delta T = T \times \frac{\rho_t}{\rho_t - \rho_s} \times \sqrt{\frac{1}{n_s} + \frac{1}{n_t}} \text{ Ma}$$

where,

ρ_t = total track density obtained for irradiated grains
n_s = number of fossil tracks
n_t = number of tracks for irradiated grains

In case of Bearch granite, apatite grains were separated using Frantz isodynamic magnetic separator followed by heavy liquid separation. 30-40 apatite grains have been separated from $\frac{1}{2}$ kg of the rock sample. The apatite grains were mounted on the piece of teflon sheet and after polishing by diamond paste, etching was carried out in 4% HNO_3 at room temperature for 50 seconds. After determining the fossil track density, the grains were heated at 600°C for one hour to anneal out all the fossil tracks. Then the grains were sent for thermal neutron irradiation in CIRUS reactor at BARC, Bombay. The induced track density was calculated after remounting and polishing the irradiated grains. The F-T age was obtained using the formula (1) and the 1σ statistical error was calculated using following equation :

$$\Delta T = T \times \sqrt{\frac{1}{n_s} + \frac{1}{n_i}} \text{ Ma}$$

4. Results and discussion

The results of F-T age measurements on gluaconitic sandstone samples and Bearch granite sample are given in Tables 2 and 3. Since the separated glauconitic pellets were dark green and well evolved type, it indicates that these deposits have not faced any heating event in the geologic past (Srivastava 1985, 1987,

Srivastava and Rajagopalan 1986) ; hence no annealing correction has been made for presently obtained F-T ages of glauconies.

Table 2. F-T age of samples from Chittorgarh district, SW Rajasthan.

Sample No.	Description	Fossil track density ρ_s (t/cm^2)	Total track density ρ_t (t/cm^2)	Induced track density ρ_i (t/cm^2)	Age (Ma)	Err (1σ)
BSFT 196/BOR-1	Bodwali Nala section, 2.5 km east of Bordi village	2.01E+03 (119,2365,2)*	6.14E+03 (159,1036,2)	4.13E+03	1070	195
BSFT 203/BR-G	Bearch Granite Det village, Chittorgarh, SW, Rajasthan	4.07E+06 (1018,10,2)		1.16E+06 (289,10,2)	1470	100

*The bracket shows number of tracks, graticules and thin-sections respectively. Area of one graticule = 2500 μm^2 (1000 × magnification, Olympus BH-2 microscope). Thermal neutron fluence (ϕ) = 3.965E+16 n/cm^2 (BOR-1) and (ϕ) = 7.804E+15 n/cm^2 (BR-G).

The F-T age for four samples BSFT 210/As-1, BSFT 216/As-7, BSFT 218/As-9 and BSFT 221/As-12 have been calculated as (650 ± 105), (640 ± 115),

Table 3. F-T age of glauconitic sandstone deposits at Astal Hillock Karauli area, Rajasthan.

Sample No.	Description	Fossil track density ρ_s (t/cm^2)	Total track density ρ_t (t/cm^2)	Induced track density ρ_i (t/cm^2)	Age (Ma)	Err (1σ)
BSFT 210/AS-1	Fine grained sandstone at 6 m height from base	2.09E+03 (118,2260,3)*	8.47E+03 (145,685,3)	6.38E+03	650	105
BSFT 216/AS-7	Fine grained sandstone at 4 m height from base	2.03E+03 (101,1990,3)	8.29E+03 (109,526,3)	6.26E+03	640	115
BSFT 218/AS-9	Coarse grained sandstone at 3 m height from base	1.97E+03 (127,2584,3)	8.36E+03 (145,694,3)	6.39E+03	610	95
BSFT 221/AS-12	Coarse grained sandstone at 1 m height just above shale	2.04E+03 (91,1783,3)	8.82E+03 (125,567,3)	6.78E+03	600	110

*The bracket shows number of tracks, graticules and thin-sections respectively. One araldite mount contains 40-90 glauconite grains. Area of one graticule = 2500 μm^2 (1000 × magnification, Olympus BH-2 microscope). Thermal neutron fluence (ϕ) = 3.46E+16 n/cm^2.

(610 ± 95) and (600 ± 110) Ma respectively. These F-T ages indicate that these samples belong to the same bed. Calculating the mean and standard deviation of the central values, the average F-T age for this bed is obtained as (625 ± 24)

Ma. The comparison of this F-T age data with that of glauconitic beds exposed at and around Bhainsrorgarh, Rawatbhata area, Rajasthan (Srivastava and Rajagopalan 1988) shows that the present bed belongs to a younger formation. Hence this bed may be considered a part of Lower Bhander sandstone formation, as indicated by Prasad (1984) in his extended map, drawn on the basis of the geological studies carried out at SW Rajasthan. A systematic collection of more samples from the area and their F-T dating will throw more light on the exact stratigraphic position of these deposits in the Vindhyan supergroup.

The glauconitic sandstone sample BSFT 196/BOR-1 from Bodwali, Chittorgarh, Rajasthan has given a F-T age of (1070 ± 195) Ma while the other sample BSFT 197/BOR-2 could not be dated due to the opacity of the grains. On comparing this age-result with that of Son Valley and Chitrakut area (Srivastava and Rajagopalan 1986, Srivastava 1987), this bed correlates with the top of Kheinjua formation, Lower Vindhyan (Semri) group (Table 1). In his detailed map, Prasad (1984) has shown these deposits as Kaimur formation. The dating of more samples from this and nearby area will resolve the stratigraphy and the age of the bed.

The apatite grains separated from Bearch granite have yielded an age of (1470 ± 70) Ma, which indicates that in this area no major metamorphic event occured post Vindhyan deposition. The track length measurement study is being carried out for this sample in order to have annealing correction on the F-T age.

5. Conclusion

Banerjee and Singh (1981) had concluded on the basis of extensive geological mapping in Sapotra-Karauli area that the Vindhyan deposits at this area belong to Lower Vindhyan group and Kaimur formation. They had compared the limestone deposits around Karauli area to Tirohan limestone of east and had also indicated the presence of glauconitic sandstone bed equivalent to Khienjua formation. At Astal Village (4 km from Karauli on Karauli-Gangapur road) from where the present samples of glauconitic sandstone have been collected, limestone is not exposed. The limestone exposures are in S-SW of Karauli. The average F-T age for this bed (625 ± 24) Ma, assigns it to Bhander formation as is shown in the extended map of Prasad (1984).

The presently obtained F-T age for glauconitic sandstone at Bodwali, Chittorgarh is the oldest radiometric age reported so far for the Vindhyan deposits in Rajasthan. Though Vinogradov *et al* (1964) has dated one sample as (1460 ± 70) Ma, the exact locality has not been described, besides, the result has been doubted by the authors themselves by putting a question mark.

The apparent F-T age (1470 ± 70) Ma for Bearch granite is comparable with the F-T age of Bundelkhand granite (1600 Ma) obtained by Srivastava and

Rajagopalan (1986) but better conclusions can be drawn by comparing the true age, obtained after completing the track length measurement study.

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